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MR. MAKHIJANI: My name is Arjun, A-R-J-U-N, Makhijani, M-A-K-H-I-J-A-N-I.

I'm president of the Institute for Energy and Environmental Research in Tacoma Park, Maryland, 20912. I've been looking at Yucca Mountain issues and nuclear waste disposal issues for quite a long time and have made extensive comments before on a number of occasions to the DOE and also to the Nuclear Waste Technical Review Board, to the Nuclear Regulatory Commission, and to the EPA. I don't believe any of these agencies have considered seriously the most important comments that I have made with the very partial exception of the

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Environmental Protection Agency.

I believe that this finding, preliminary finding of site suitability, is not scientifically, not based on sound science. It ignores or underplays profoundly significant environmental and security issues that may affect future generations for a very long time.

I am very disturbed by the process that, by which this has been released and the very short amount of time that has been given to people to comment and,

especially in light of September 11th when everybody's minds have been on other very difficult issues, I think that not extending the time of comment substantially so people could respond thoughtfully has undermined the democratic process, but really is in line with many other things the department has done to undermine that process in the past in relation to its repository program since 1982.

I have a number of specific comments in regard to how the Yucca Mountain site suitability determination is being made. My first comment is that the whole consideration is contrary to common sense and elementary considerations of the second law of thermodynamics. The second law of thermodynamics says that in the absence of any organized energy input and a

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machine, that you will tend to have corrosion and dispersal and that anything that's concentrated will tend to diffuse and being diluted over time.

Repository considerations have, at Yucca Mountain, have never properly incorporated or, to my knowledge, even explicitly incorporated considerations of this most fundamental law of physics by Einstein considered to be the most durable law of physics, by

the way.

The geologic environment at Yucca Mountain is an oxidizing environment and the engineered barriers, the basic engineered barrier that is sought to be put in Yucca Mountain on the basis of which site suitability is being made is a metal canister. Its fundamental principle is well established in chemistry that with even the moderate amount of humidity, heat, and oxygen will combine to corrode metal. This very basic experience of experimental and theoretical chemistry, which is the second law of thermodynamics, has not been adequately considered in the evaluation of site suitability.

There is only a few years of data regarding corrosion for the particular alloy that is sought to be put in this geologic repository. This data is a grossly insufficient basis on which to make

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extrapolations to 10,000 years or longer. 10,000 years is the regulatory time, but peak dose will occur 100,000 or more years from now or from site closure and DOE has made calculation for 100,000 and 200,000 years, without any serious discussion of the immense uncertainties that confront such projections, given the

fact that there is almost no data on what is a newly-created alloy in a highly complex geologic environment.

Yucca Mountain is generally acknowledged to be one of the most complex geologic environments in the world and, in many ways, unique. And to ignore the principles of physics and the second law of thermodynamics by putting metal canister in an oxidizing environment and then to have insufficient data, I think, underlines the scientific bankruptcy of the process and the determination to ignore the basics of sound science that are required in any good repository program.

DOE has been consistent in this, not only in Yucca Mountain, but in other parts of the repository program since 1982 and there is an ample public record of my own writing and other people's writing of which the DOE is quite aware and I would like to state here that the DOE should review this ample public record.

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A part of this ample public record is the 1983 report by the National Research Council on Geologic Isolation which was commissioned by the Department of Energy and, to date, I have found no

serious evidence that the department has ever considered carefully the recommendations in a report it itself commissioned, much less take those basic science recommendations and geologic isolation recommendations into account in its work. In fact, in many of its publications, DOE publications, one cannot find even a reference to this report in the reference list, much less any serious consideration of it.

As another specific, there have been, since the 1980s, much controversy regarding the upwelling of the water table into the repository horizon. This has been dismissed by the DOE and the U.S. Geological Survey on several occasions. But in light of questions raised by research done by my institute, the Department of Energy agreed to commission research project at the University of Nevada in Las Vegas on which about $2 million were spent and on the basis of which the idea that there could be upwelling in the recent geologic past, less than a few million years, has been dismissed.

However, prior to standard scientific

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practice that has long been established, the department has not published this data and has not made it

available despite repeated requests. The data, according to the researcher herself, are not in a shape to be made public for many months so that independent review of this data has been precluded and yet the department has made public its own agreement with the idea that these data indicate that there has been no recent upwelling in the geologic past.

There have been some questions about the methodology relating to these conclusions and I will mention two specific areas here. One area relates to the method of data, uranium lead dating. The background amount of lead that has been assumed for this may not be an appropriate one, raising questions about the entire application of the dating method to this particular situation. I have written a letter to the Nuclear Waste Technical Review Board on this subject and others on the 25th of May and I wish that letter to be a formal part of my comments and I believe the DOE should be able to access the public record because that letter should be in the public record and has been received by the Nuclear Waste Technical Review Board.

Another difficulty with the dating that has

been done, which has been raised by me and Dr. Yuri Dublyansky, D-U-B-L-Y-A-N-S-K-Y, also a scientist well known to the Department of Energy -- a point that he has made, which I reinforced in my letter to the Nuclear Waste Technical Review Board, was that for the postulate that the hot water that has been found in the minerals in Yucca Mountain at the repository horizon to be older than 5 million years would require highly constant temperatures in the repository for millions of years and this appears to be thermodynamically, essentially impossible on probabilistic ground.

The basic thermodynamic arguments raised by Dr. Dublyansky have not been addressed by the DOE. This is again a question of the second law of thermodynamics. We keep coming back to the second law of thermodynamics. It's a long-established principle in physics and the Department of Energy has arrived at conclusions of site suitability with substantial disregard of the principles of physics and this is highly troubling to me and I believe it should be troubling to policymakers and I do not believe that this site suitability recommendation should be accepted. I believe the DOE should change it and defer

any assessment of site suitability until these questions can be thoroughly and publicly settled.

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I don't believe there is any room for argument about the second law of thermodynamics or whether temperatures can be maintained to within fractions of a degree for millions of years. I think this is so improbable as to constitute physically incredible events.

I don't know if the calculations of Dr. Dublyansky are correct and I have not checked them myself, but I know that he's a very good scientist and I believe that his concerns deserve full and careful consideration and I have looked over his work and I'm convinced that it is of sufficient merit that no site suitability recommendation in regard to thermodynamics of the repository can be made without fully and carefully addressing all of them.

Besides the uncertainty regarding upwelling, there is also the uncertainty regarding migration of radionuclides. There are indications from the general area of the Nevada test site and Yucca Mountain that radioactivity migrates fast and that there are immense variations in the velocity of water through the

22 geologic medium in the vadose zone.

23 When all of the uncertainties in the

24 parameters in corrosion in the geology are taken into

25 account, the uncertainties and calculations are, I

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1 believe, much, much more vast than what is indicated in

2 DOE's presentation. I think the uncertainties are

3 likely to be of many orders of magnitude and these

4 uncertainties have been made to disappear with

5 inappropriate modeling procedures that are not

6 adequately founded in scientific data. The vadose zone

7 is the zone between the surface of the earth and the

8 top of the water table. It's the unsaturated geologic

9 zone.

10 The DOE has considered human intrusion, but

11 it has inappropriately done so. It has ignored

12 deliberate human intrusion and I believe that is

13 inappropriate. It has considered inadvertent human

14 intrusion 100 years after the closure of the

15 repository. I believe that this is far too soon. I

16 believe the point of human intrusion assumed should be

17 within the repository footprint or at least at the edge

18 of the repository and the time should be 1,000 years or

19 more after closure. I think considering intrusion

20 after 100 years and assuming that all canisters are
21 going to be intact as guaranteed to yield a result that
22 is a very low dose and I think generally the DOE's
23 calculations appear to be geared in the direction of
24 setting up scenarios that will provide a predetermined
25 result.

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1 I want to note here that the initial
2 calculations done for Yucca Mountain doses by the
3 National Academy of Sciences in 1983 yielded peak doses
4 that are hundreds of thousands of times bigger than
5 what the DOE is now calculating and, in the worst case,
6 millions of times bigger than what the DOE is now
7 calculating.
8 While changes in estimates are certainly
9 possible with the progress of science, my own
10 evaluation of DOE's scientific credibility that it has
11 not made sufficient progress in the science to provide
12 such narrow uncertainties in the dose estimates and to
13 ignore the possibility that Yucca Mountain-related
14 ground water will not result in huge radiation doses to
15 future generations far, far above allowable standards.
16 I believe that after September 11th, after
17 the tragic terrorist attacks of September 11th, that

the Department of Energy should have paused and reconsidered its site suitability recommendations. The whole arrangements for the phasing of loading the repository will require prolonged storage of nuclear waste in very large quantities in surface facilities.

The security implications of gathering all this nuclear waste in one place should be very carefully evaluated and they have obviously not been

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because this was prepared before September 11th and all of us, of course, are quite aghast at many things, all of us, including me. So this is not finger-pointing at the DOE. All of us considered many things incredible that, unfortunately, we must no longer consider incredible.

Similarly, the location of a repository in the west, with most of the reactors being in the east and midwest, which will require transportation over vast distances, must be reconsidered. And this has not been reconsidered in light of the events of September 11th.

The National Academy had said in 1983 in its report, although not in so many words, but the clear implication of the National Academy's work is the most

suitable sites geologically may be located in the east. They are also certainly closer to the nuclear waste and would minimize transportation requirements.

And while I realize that the DOE is not charged with comparing repositories under the 1987 legislation, it is the responsibility of the DOE to point out the additional hazards that will result under present circumstances from unnecessary transportation of nuclear waste. I believe that the DOE should withdraw the site suitability draft report and

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completely revamp it and prepare it with adequate scientific data, especially as regards to corrosion issues associated with the canisters and waste transportation issues across the country, as well as transport of radionuclides within the repository under various conditions.

I have commented to the EPA and NRC how unsatisfactory their standards are and I won't enter into that discussion here because I realize that the DOE is operating, preparing its site suitability within the standards that have been set by the EPA and NRC. However, it's not beyond the scope to note here that the DOE resisted more stringent standards by the EPA

and held them up for many years in bureaucratic processes to the point that we are now faced with the situation where we shall have an exclusion zone of, for this repository, of 11 miles from the Safe Drinking Water Act. All of the water under Federal land is thereby excluded from the Safe Drinking Water Act and this, I believe, sets a devastating precedent for safe drinking water protections for the entire west where so much land is Federally owned.

I believe that this particular environmental impact and its implications are a direct result of DOE resisting the general application of the Safe Drinking

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Water Act to the Yucca Mountain repository and at least should be frankly acknowledged and considered as part of the environmental impact of this repository process because that impact, I believe, could be extremely widespread.

The temperature considerations for the repository have not been adequately discussed. The DOE has not yet decided whether this is going to be a cold repository or a hot repository. It references cases it is a hot repository, so far as I can tell. The presentations before the Nuclear Waste Technical Review

Board made by independent scientists indicate that a hot repository cannot really be adequately modeled because of the disturbance that it may create in the geologic environment. But overriding the expert advice of independent scientists, the DOE apparently has found ways to do what the most experienced scientific experts in the country have found essentially impossible, or, yes, beyond essentially impossible to do within the kinds of uncertainties that the DOE has presented.

I believe the DOE should rule out a hot repository scenario, but it has refused to do so because, I believe, that a partial political consideration is preventing it. Hot repositories do allow you to stick a lot more waste in the repository

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because it can be more closely packed.

I do not agree with the whole approach that there should be a total system performance assessment as the method for licensing a repository. This means there should be no backup, that you only have one performance assessment of the whole system and if your performance assessment is wrong for some reason, there is no backup.

In the original conception that we

recommended and have long recommended, the engineered barriers and canisters should independently meet safety and radiological criteria and the geologic barriers should also meet those standards so the geologic medium is serving as a backup. DOE's calculations show that Yucca Mountain is essentially useless as a geologic containment medium and once the canisters are breached, that there will be rapid transport and pollution of the aquifer through the geologic medium. Given this, the insistence that Yucca Mountain should be the site is not scientifically reasonable or rational and I believe, I have long believed that the Yucca Mountain, the data and evidence for Yucca Mountain as a geologic medium to be inappropriate has long been quite strong and that this recommendation is inappropriate.

Finally, the water, the amount of water that

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would percolate into the repository, the estimates of that have varied a great deal just in the last decade and a half. I believe this is indicative of the kinds of uncertainties that the DOE has not adequately factored in. If these basic parameters can change by an order of magnitude with modest amount of research, it certainly raises questions as to what else can

change by an order of magnitude with more thorough and careful research.

I believe the DOE research has consistently been biased in the direction of not finding adverse, not pursuing those scientific leads that could result in a finding that the site was not suitable and there has been a great deal of politicizing and shifting the goalpost in regard to the standards in which this repository should meet. These standards have already been adjusted three times, I believe, in order to accommodate this repository -- once for carbon-14, once for NRC, once for changing the calculation procedure to the total system performance assessment.

I believe the public record of the Nuclear Waste Technical Review Board, of my institute's work, of the work of other independent scientific institutions, is replete with indications that the uncertainties are far more vast than what the DOE has

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presented in the site suitability report and I don't believe that the DOE is fulfilling its mandate to protect the public health of future generations and conducting a sound repository process.

Again, finally, I say this site suitability

assessment draft, preliminary assessment evaluation should be withdrawn and, for the various reasons that I have cited, it should be deferred until a thorough and careful assessment can be prepared. This is not a thorough and careful assessment.

Thank you very much.